Physics Programme

Department of Physical Sciences,
Institute of Advanced Research,
Koba Institutional Area, Gandhinagar – 382426.
Gujarat, India.

Cover Page: https://xdesktopwallpapers.com/beautiful-blue-and-pink-optical-fibre-lamps-25673.php

Message from the President

IAR, Gandhinagar

The grand challenges that the society faces today can only be met by education and research driven innovation. Whether it is the impact of climate change, resource depletion or life-long health and well being, these can only be confronted by the advancement of knowledge and its application. The Institute of Advanced Research is committed to developing and delivering world-leading higher education programs that are underpinned by relevant research. Education disconnected from the real world context does not necessarily lead to graduates who will be the driving force for growth of the economy and, social and environmental well-being that we seek. Therefore, students at the Institute of Advanced Research (IAR) actively interact with society, business and industry through extra-curricular and co-curricular programs.
Our students and faculty benefit from a structured interaction with business and industry leaders through open lectures, collaborative research and innovation, business competitions, industry visits and voluntary work in society.
Increasingly complex problems demand ever innovative solutions, which can only be realized through multi-disciplinary education, research and application, which are all intertwined. Acquisition of knowledge is one but important aspect of university education. Our focus is also on developing our students as confident and enterprising individuals as we believe that confident and enterprising graduates will be the future leaders and change-makers in our society.

We are a young and growing university, allowing us for setting the agenda for innovative university education, research and enterprise to contribute to the social and economic advancement of our state and our nation.

I warmly welcome you to join us in this journey.

Professor Rao Bhamidimarri
President

Brochure is organized as:

- Some photos from the discipline activities
- Welcome Message from the Physics Discipline
- The Postgraduate Programme
- The Undergraduate Programme
- Our Faculty
- Activities conducted by the Physics Discipline
- Career Options following Undergraduate and Postgraduate degrees

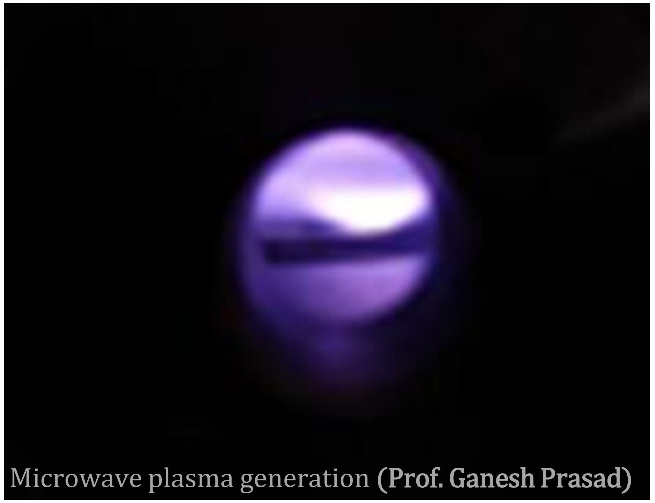
Public Lectures

Scientific Tours

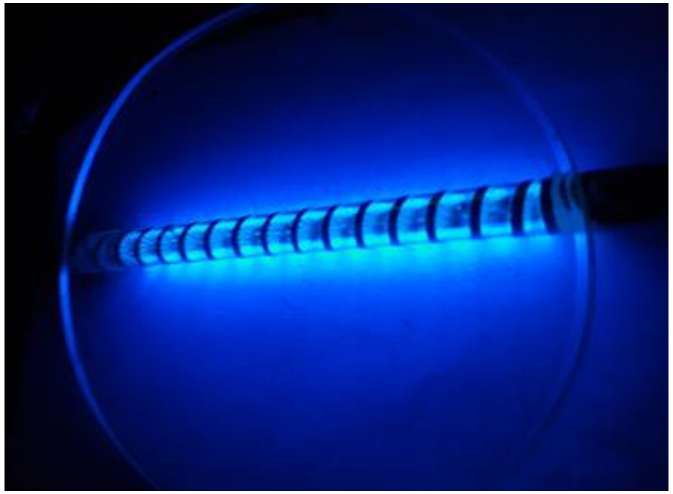
Convocation ceremony

Experimental Setups at the Physics Laboratory

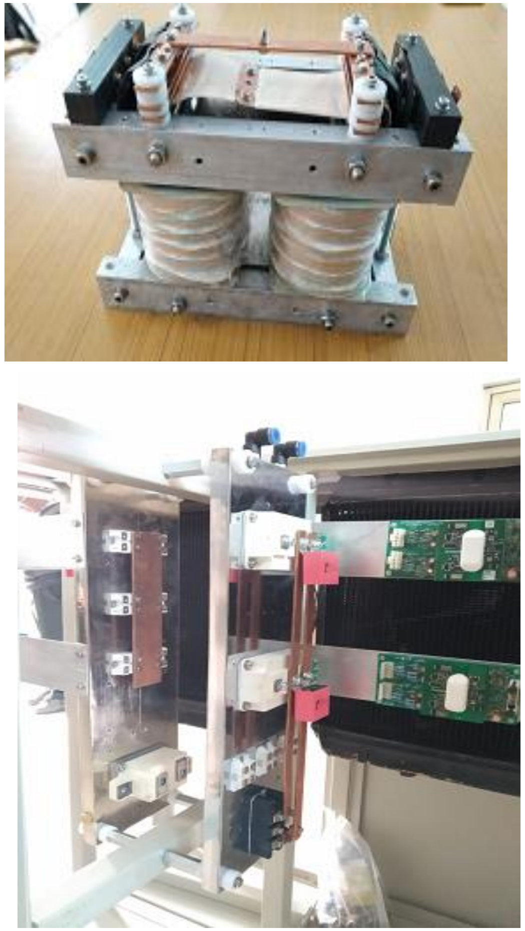
The Plasma Physics Laboratory



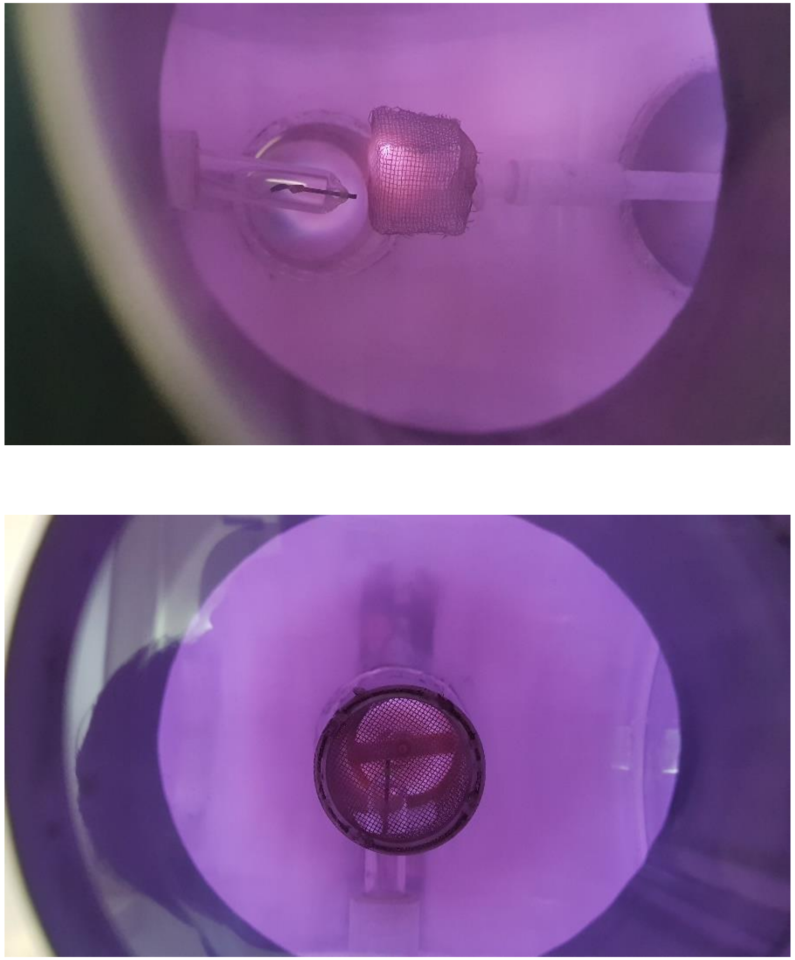
Microwave plasma generation **(Prof. Ganesh Prasad)**



Xenon Iodide Plasma for generating UV radiation for water purification: High frequency low wattage power supply is made to power the Xenon Iodide lamp which is used as UV source for sterilizing water. Xenon iodide is non mercury based lamp. Lamp was supplied by supplier for trial purpose. It is M.Sc. III & IV semester project. (Prof. Ganesh Prasad)



Development of IGBT power supply including foil type transformer winding (Prof. Ganesh Prasad)



Plasma Fireball (Dr. Payal Pandit)

PSSI - Plasma Scholars’ Colloquium (PSC-2019) will be held at IAR, Gandhinagar.

Computer Laboratory (One of the two computer laboratories)

Welcome Message

We at the Physics discipline at Institute of Advanced Research (IAR) extend a warm welcome to you. We are a fast expanding group, running the Undergraduate (UG), Postgraduate (PG) and Ph. D. programs. The Physics discipline at IAR comes under the Department of Physical Sciences headed by Dr. Roli Mishra.

The programmes have well furnished state-of-the-art laboratories which has fully functioning experimental setups to cater to UG and PG courses. The postgraduate course has general physical laboratories for all semesters as practical work is an indispensable component of a complete and fundamental understanding of the subject. The syllabus is designed so that it prepares the students for NET/GATE and other competitive examinations. The discipline regularly organizes Public Lectures which are delivered by eminent scientists from within and outside Gujarat.

Recently the department with Dr. Gurudatt Gaur as the coordinator has become an **ICARD [IUCAA centre for Astronomy and Research and Development] centre.** This has opened a window of opportunity for the discipline to host programs and courses related to Astronomy. IAR will be a centre with an active public outreach program for Astronomy. Astronomers can visit this institute and give lectures and take courses.

The discipline has a good structure of teaching and research. The discipline carries out research in gravitational wave astronomy, theoretical and experimental plasma physics and theoretical and experimental condensed matter physics. PSSI - Plasma Scholars' Colloquium (PSC-2019) will be held at IAR, Gandhinagar with Prof. Ganesh Prasad as the coordinator.

The faculty of the discipline has collaborations with neighboring institutes and students pursuing their Masters can become a part of this collaboration through their project work which is an extensive part of the curriculum in the final semesters.

Course Structure Details

- Postgraduate Program

Postgraduate Programme in Physics:

The Masters in Physics (MSc. Physics) course which started in the Academic year 2017 has a current strength of 23 students. The course structure requires a total of 88 credits over a period of two years comprising of four semesters to be completed to qualify for a degree. For each semester a student should complete 22 credits. The structure of the course is so designed that it includes core subjects which are mentioned in the syllabus for National Eligibility Test. The students are also given a flavor of current research trends and topics as elective subjects in the final semesters. These electives can be chosen from a plethora of choices ranging from Plasma Physics, General Relativity to topics in Advanced Condensed Matter, Nanoscience and Nanotechnology and so on (Kindly refer the complete list of electives offered, Pg. 10). The course contents also prepares students to appear for various entrance tests at the national level (NET/GATE/JEST, etc.,) and qualify for research fellowships in esteemed research institutes across the country and abroad.

Considering the fact that laboratory work is an integral part of any successful masters' programme, all four semesters have a mandatory General physical Laboratory. The other important focus is on developing the computational skills of a student which has stupendous importance in today's job-market and research-pursuit. In this course spanning over two semesters a student is taught linux and unix, programming languages C and Python, basic plotting techniques like gnuplot, latex and numerial methods.. These techniques are taught through solving basic and interesting problems.

We have a very healthy and active interacting atmosphere in the campus between the faculty and the students. The faculty is friendly and approachable. Students are encouraged to ask questions and clear their doubts even after their class hours. They are taken on scientific tours; regular public lectures are organized by the discipline and students can interact with eminent scientists from across the country.

Project Work and Summer Schools (MSc Program)

An important component of the course structure is the Project work which starts in the third semester and continues until the end of the fourth semester. The topics for the projects can be proposed by the student and in some cases a student can choose to work with a preferred mentor. A Project also has a scope for a student to work in collaboration with faculty from neighboring institutes.

In our current Batch (Batch 2018) students will be working on projects in collaboration with Faculty from Institute for Plasma Research, Gandhinagar, Pandit Deendayal Petroleum University, Gandhinagar, Physical Research Laboratory, Ahmedabad and Indian Institute of Technology, Gandhinagar. The purpose of these collaborations is to expose students to a different working environment, encouraging them to interact with students outside their own campus and help them adjust to situations beyond their comfort zones. Apart from enhancing their scientific knowledge, they would also learn about life beyond the university.

The students are also encouraged to apply and visit research institutes across the country during summer programs or summer schools. Ms. Nishka Seth (Batch 2017) has attended the DST-SERB School on Ultrahigh Intensity Laser Produced Plasmas : Physics and Applications, organized by laser plasma division RRCAT-Indore. Ms. Madhavi Agarwal (Batch 2018) will be attending the summer school in Indian Institute of Science and Technology, Thiruvananthapuram.

We have taken our students on a scientific visit to IPR, Gandhinagar to see the research facilities. Students also attended a conference in IIT, Gandhinagar following which they also saw some of the instruments set up in connection with experimental condensed matter physics.

MSc. Course Curriculum

Core Papers

1. Mathematical Physics – I
2. Mathematical Physics – II
3. Classical Mechanics
4. Quantum Mechanics – I
5. Quantum Mechanics – II
6. Statistical Physics
7. Electronics
8. Electrodynamics
9. Condensed Matter Physics
10. Atomic, Molecular and LASER Physics
11. Nuclear and Particle Physics

Compulsory Laboratory:

General Physics Laboratory, I,II, III, IV
Computational Laboratory I, II;
Special Lab I, II

Project Work

Elective Papers

Elective I (for Semester – III)

Advanced Condensed Matter Physics
Plasma Physics
Experimental Techniques

Elective II (for Semester - IV)

General Relativity
Nano Science and Nano Technology
Biophysics

MSc. Course Curriculum

Semester	Code	Name	Credits		
			Lecture	Practical	Total
I	MAT 801	Mathematical Physics – I	4	0	4
	CM 801	Classical Mechanics	4	0	4
	QM 801	Quantum Mechanics – I	4	0	4
	ELTR 801	Electronics	4	0	4
	CPL 801	Computational Laboratory – I	0	2	2
	GPL 801	General Physics Laboratory – I	0	4	4
		Total			22
II	MAT 802	Mathematical Physics – II	3	0	4
	SMP 801	Statistical Physics	4	0	4
	ELEC 801	Electrodynamics	4	0	4
	CMP 801	Condensed Matter Physics	4	0	4
	CPL 802	Computational Laboratory – II	0	2	2
	GPL 802	General Physics Laboratory – II	0	4	4
		Total			22

Semester	Code	Name	Credits		
III	QM 802	Quantum Mechanics – II		0	4
	AMP 801	Atomic, Molecular and LASER Physics	4	0	4
	ELP 801	Elective – I		0	4
	GLP 803	General Physics Laboratory – III	0	0	4
	PRJ 801	Project – I	0	4	4
	SPL 801	Advanced Computational Laboratory – I Or Special Laboratory – I		2	2
		Total			22
IV	NPP 801	Nuclear and Particle Physics	4	0	4
	ELP 802	Elective – II		0	4
	GPL 804	General Physics Laboratory – IV		0	4
	PRJ 802	Project – II	0	8	8
	SPL 802	Advanced Computational Laboratory – II Or Special Laboratory – II	0	2	2
		Total			22

Course Structure Details

- ❑ Undergraduate Program

Undergraduate Programme

We often forget that the world wide web (www) that we have today happened because of research in high energy particle physics which required huge amounts of data to be processed and communicated. Degrees in basic sciences, like Physics, Chemistry, Mathematics and Computer Science can never run out of fashion because the knowledge gained by an individual pursuing this course ensures a training which prepares them to tackle challenges put forth by a myriad of job types.

The Physics discipline at Centre for Engineering and Enterprise (CEE) offers the Undergraduate Courses BSc with Physics and BSc, Physical Sciences. To obtain either of the degrees the student will have to take Physics as one of the three core subjects from a combination:

Core (DSC) and Elective (DSE) -1	PHYSICS	PHYSICS	PHYSICS
Core (DSC) and Elective (DSE) -2	CHEMISTRY	CHEMISTRY	MATHEMATICS
Core (DSC) and Elective (DSE) -3	MATHEMATICS	COMPUTER SCOEINCE	COMPUTER SCIENCE

(Please refer next page for clarification of DSC and DSE)

According to University Grants Commission (UGC) guidelines the undergraduate degree will be awarded on a completion of 120 credits over a span of 6 semesters. The first batch graduated in August 2017, and the students are now pursuing Masters at IAR as well as other universities in and around Gandhinagar, Gujarat.

IAR has well equipped state-of-the-art laboratories for excellent practical work which provides an excellent hands-on skill development. With well-trained faculty we have the advantage of offering specialized subjects towards the end of the course which will benefit the students with a career interest in research. Students are also encouraged to visit institutes across the country for summer programs which will expose them to working in a different environment with experts in the respective fields. This course at IAR helps a student develop good analytical, technical and communication skills which prepares him/her for successful careers in various fields after graduation.

Note about the Subject Categories:

In order to obtain a degree under **BSc with Physics** or **BSc with Physical Sciences with Physics as one of the subjects** the curriculum mentioned in the next page is followed. DSC stands for Discipline Specific Core subjects. One of the three chosen subjects is Physics, the other two (DSC-2 and DSC-3) can be Chemistry/Mathematics/Computer Science (see the table in Page 13). This combination should be maintained throughout six semesters. In the fourth and fifth semesters the DSE or Discipline Specific Electives should be from the choice undertaken by the student at the beginning of the course (i.e., in the 1st Semester).

For example if a student chooses Physics, Chemistry and Mathematics as his/her combination, then DSC-1 and DSE-1 are Physics subjects and DSC-2, DSE-2 will be Chemistry subjects and DSC-3, DSE-3 will be Mathematics subjects. (In the semester curriculum A, B, C and D refer to subsequent semesters.)

Along with the Discipline Specific Cores and Discipline Specific Electives, the students will have to compulsorily attend Ability Enhancement Courses (AEC) in the 1st and 2nd Semesters (one in 1st and the other in 2nd Semester).

The student will attend Skill Enhancement Courses (SEC) starting from the 3rd Semester up to the 6th Semester (one each in 3rd, 4th, 5th, and 6th Semesters). The student with an avid interest in Physics or wishing to pursue Physics for higher studies is recommended to choose SEC from the Physics discipline. The student can choose SEC from any one of the three subjects he/she has chosen at the beginning of the course.

BSc. Course Curriculum

Core Papers

1. Mechanics + Lab
2. Electricity, Magnetism and Electromagnetic Theory + Lab
3. Thermal Physics and Statistical Mechanics + Lab
4. Waves and Optics + Lab

4+4 more core papers from the disciplines Mathematics/Chemistry/Computer Science/Electronics. (DSC-2, DSC-3)

Elective Papers (DSE-1A, DSE-1B)

1. Digital, Analog and Instrumentation + Lab
2. Elements of Modern Physics + Lab
3. Mathematical Physics + Lab
4. Solid State Physics + Lab
5. Quantum Mechanics + Lab
6. Embedded System: Introduction to Microcontroller + Lab
7. Classical Mechanics + Lab
8. Biophysics+ Lab

2+2 more core papers from the disciplines Mathematics/Chemistry/Computer Science/Electronics. (DSE-2, DSE-3)

Ability Enhancement Papers (One each in first two semesters)

English / MIL communications / Environmental Science

Skill Enhancement Papers (One each in third to sixth semesters)

BSc. Course Curriculum

The 3-year 6-semester curriculum BSc with Physical Sciences, with Physics as one of the core subjects is given above. Apart from Physics the student can choose two other subjects (DSC-2 and DSC-3/DSE-2, DSE-3) from Chemistry/Mathematics/Computer Sciences.

Semester	Code	Name	Credits			
			Lecture	Tutorial	Practical	Total
I		Mechanics	4	0	2	6
		DSC – 2 A	---	---	---	6
		DSC – 3 A	---	---	---	6
		Ability Enhancement Paper – I	2	0	0	2
		Total				**20**
II		Electricity, Magnetism and Electromagnetic Theory	4	0	2	6
		DSC – 2 B	---	---	---	6
		DSC – 3 B	---	---	---	6
		Ability Enhancement Paper – II	2	0	0	2
		Total				**20**
III		Thermal Physics and Statistical Mechanics	4	0	2	6
		DSC – 2 C	---	---	---	6
		DSC – 3 C	---	---	---	6
		Skill Enhancement Paper – I	---	---	---	2
		Total				**20**

Semester	Code	Name	Credits			
			Lecture	Tutorial	Practical	Total
IV		Waves and Optics	4	0	2	6
		DSC – 2 D	---	---	--	6
		DSC – 3 D	---	---	--	6
		Skill Enhancement Paper – II	---	---	---	2
		Total				**20**
V		DSE – 1 A (Physics)	---	---	---	6
		DSE – 2 A	---	---	---	6
		DSE – 3 A	---	---	---	6
		Skill Enhancement Paper – III	---	---	---	2
		Total				**20**
VI		DSE – 1 B (Physics)	---	---	---	6
		DSE – 2 B	---	---	---	6
		DSE – 3 B	---	---	---	6
		Skill Enhancement Paper – IV	---	---	---	2
		Total				**20**

Faculty

Dr. Gurudatt Gaur
Assistant Professor
(DEAN, Academic)

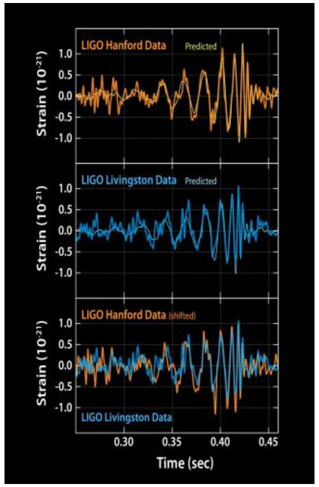
B.Sc. (Hons): Aligarh Muslim University, Aligarh, 2003
M.Sc.: Aligarh Muslim Uniersity, Aligarh, 2005
Ph. D.: Institute for Plasma Research, Gandhinagar, Gujarat, 2013

Dr. Gurudatt Gaur is an Assistant Professor of Physics at IAR, Gandhinagar since 2015. During his PhD at IPR, Gandhinagar he worked on shear driven instabilities in plasmas. Later he joined as a postdoc at IPR, Gandhinagar to work on gravitational wave data analysis, in collaboration with IIT Gandhinagar. He is a member of the global LIGO Scientific Collaboration and the Indian Initiative in Gravitational Wave Observations (IndIGO), AAPPS-DPP and PSSI. He is also a Visiting Associate at IUCAA, Pune. He is actively involved in the Science and Engineering programmes at IAR.

More at: http://iar.ac.in/faculty2-engi-gurudatt-gaur.html

Email: gurudatt.gaur@iar.ac.in

Research Interests: Gravitational Wave Astronomy and Plasma Physics



We are now in the ere of a new Astronomy – Gravitational Wave Astronomy, marked by the first ever observation of gravitational wave signal in the two LIGO detectors on September 14, 2015. Since then more signals have been detected. The sources for the signals detected are the binaries of compact objects (neutron stars / black holes). Due to small SNR, the GWs can not be observed directly. Strategies of data analysis are developed to detect GW signals and to extract the physics from the detection(s). Our group is working on coincident detection and parameter estimation of gravitational waves emitted from binaries of compact objects.

Plasma is also known as the fourth state of matter essentially a collection of charged and neutral particles. Most of the plasma in the universe can be modeled using the fluid description (e.g. MHD). Consequently, well know fluid instabilities are ubiquitously studied in plasma. Since the species (electrons, ions) are charged, there are intrinsic length and time scales also present there, which makes the plasma instabilities very rich and interesting. The instabilities lead to the evolution of the equilibrium configurations, sometimes to the point of complete destruction. We try to understand the behavior of shear driven instabilities and the ways to suppress them.

Image: GW Signals as observed by the two LIGO detectors.
[https://www.ligo.caltech.edu/image/ligo20160211a]

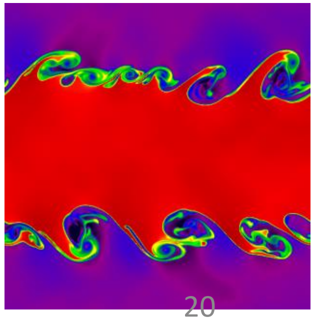


Image: Kelvin-Helmholtz instability.
[https://www.astro.princeton.edu/~jstone/Athena/tests/kh/kh.html]

Dr. Jaita Banerjee
Assistant Professor

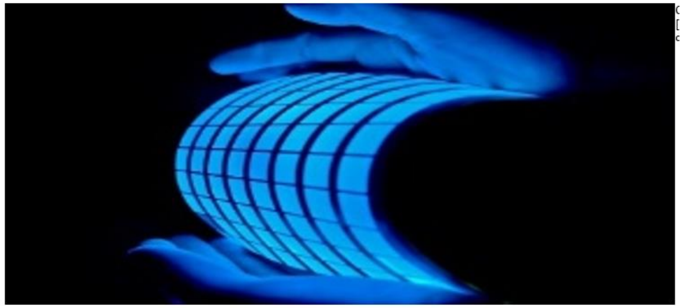
B.Sc. (Hons): Bethune College, University of Calcutta, 2000
M.Sc.: University of Calcutta, 2002
Ph. D.: Jawaharlal Nehru Centre for Advanced Scientific Research, Bangalore, 2009

Dr. Jaita Banerjee is an Assistant Professor of Physics at IAR, Gandhinagar since July 2016. She was a visiting Assistant Professor at the Adani Institute of Infrastructure Engineering, Gandhinagar. She worked on theoretical condensed matter physics during her Ph. D. at JNCASR, Bangalore. She has post-doctoral research experience from IISER Kolkata, SNB National Centre for Basic Sciences, Kolkata, and Universitaet Tuebingen in Tuebingen, Germany. She is actively involved in teaching undergraduate students and designing Masters course in Physics.

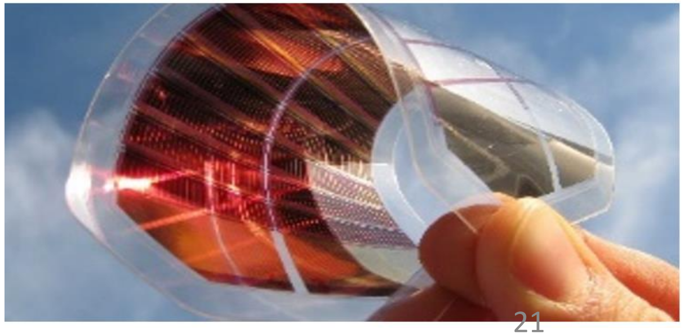
More at: http://iar.ac.in/faculty2-engi-jaita-banerjee.html

Email: jaita.banerjee@iar.ac.in

Research Interests: Interface Energetics in Organic Optoelectronics



Organic Electronic and Optoelectronic devices such as Organic Light Emitting Diodes (OLEDs), Organic Solar Cells (Organic Photovoltaic devices) have gathered a lot of attention due to its wide technological applications and intriguing research interest at the fundamental level due to the fascinating physics and chemistry of the materials involved. Organic semiconducting molecules are available in plenty variety and they have the remarkable property of being flexible, i.e., they can be molded in any desirable shape. This property also reduces their brittleness. However their conductivity is much less compared to inorganic counterparts (e.g., Si) and hence even though their mass production is cheap (compared to Si/inorganic materials) attaining the expected efficiency of devices remains a challenge.



Density Functional Theory (DFT) – a very efficient theoretical tool helps to study structural and electronic properties of materials. The interfaces formed by two organic molecules (one as acceptor and one as donor) or between a molecule and a metal in the architecture of an OLED or OPV are crucial deterministic parts of the efficiency of a device because it is at this interface charge transfer takes place. The dissociation, transport and recombination of charges finally determine how efficiently the device functions. These charge transfers in turn can be analyzed on the basis of the energy structure at the interface. The primary focus of my research is to study this interface energetics by analyzing the geometric and electronic structure properties (of such interfaces) using DFT. Using DFT with interesting and intelligent choices of materials it is possible to design new organic electronic/optoelectronic devices.

Mr. Chirag Makwana

Lecturer

B.E. : LDCE, Gujarat University, Ahmedabad, 2010
M.Tech. : DDIT, Dharmsinh Desai University, 2014

Mr. Chiarg Makwana obtained M. Tech. in Electronics and Communication Engineering from Dharmsinh Desai University Nadiad. He is currently working as Lecturer in the Physics discipline, Centre for Engineering and Enterprise, Institute of Advanced Research. He has 15 months industrial experience as an Assistant Engineer in Tulip Telecom Ltd. His area of research is Digital VLSI field (CMOS and FinFET technology).

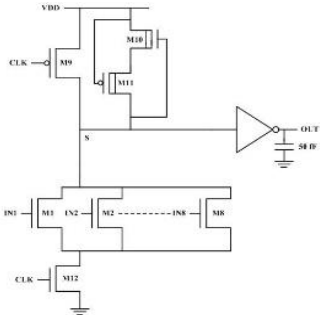
Industrial Experience: Worked as an Assistant Engineer for 15 months in Tulip Telecom Ltd.
Research Area: Digital VLSI (CMOS and FinFET technology), Embedded System, Arduino based IOT (Home Automation and Robotics)
Subject taught: Basic Electronics, Digital Electronics, Microprocessor and Microcontroller, Computer Network, Electronics
Teaching Experience: 3 years 7 months
More at: http://iar.ac.in/faculty2-engi-chirag-makwana.html

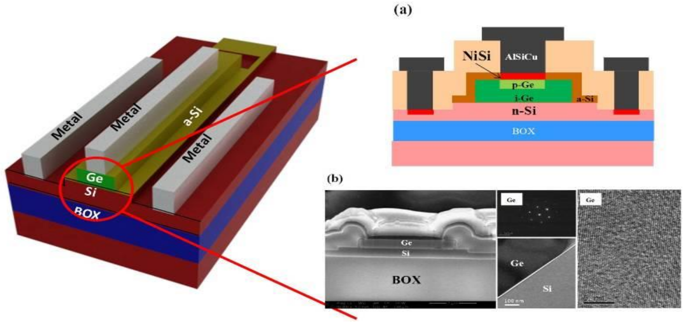
Research interests: Circuit Techniques to Improve Noise Immunity of CMOS Dynamic Logic

DIGITAL integrated circuit noise has become one of the foremost issues in the design of very deep submicron VLSI chips. Noise in digital integrated circuits refers to any phenomenon that causes the voltage at a node to deviate from its nominal value. While these noises always existed, in the past they had little impact on the performance of integrated circuits and were often neglected. It is the unstopped aggressive technology scaling in an effort to continuously improve chip performance and integration level that makes noise play an increasingly important role in comparison with conventional design metrics like area, speed, and power consumption.

Together with technology scaling, wide fan-in dynamic gates are routinely employed in performance-critical blocks of high-performance chips, such as in microprocessor, digital signal processor, and so on.

But the criticism on dynamic circuits is often related to their relatively poor noise tolerance. The dynamic logic gates inherently have less noise immunity and therefore they are the weak link in a high-performance VLSI chip designed using deep submicron process technology. The various feedback keepers are used in order to enhance noise tolerance of the dynamic circuits along with high performance.





Dr. Cliff Kant
Lecturer

B.Sc. (Physics): K.K. Shah Science College, Gujarat University, 2009
M.Sc. (Physics): School of Sciences, Gujarat University, 2011
Ph. D.: School of Technology, Pandit Deendayal Petroleum University
Raisan, Gandhinagar, 2018.

Dr. Cliff Kant is a Lecturer of Physics at IAR, Gandhinagar since April 2016. He worked on theoretical physics, modeling and simulation of Novel/Nanostructured photovoltaic devices during his Ph. D. at PDPU, Gandhinagar.

Email: cliff.kant@iar.ac.in

More at: http://iar.ac.in/faculty2-engi-cliff-kant.html

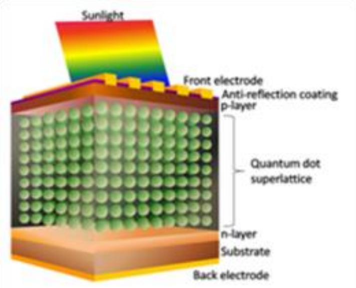
Research Interests: Quantum Dot Solar Cells

Due to the high demand for clean renewable energy, the devices meeting this need using the solar energy are investigated, researched and engineered. The basic solar cell/panels that are available in the market have commercial efficiency of 20% with theoretical thermodynamic efficiency of 33%. The embedding of Quantum Wells (QWs) or Quantum Dots (QDs) in such devices can increase their efficiency to 60% for single bandgap homojunction device.

Due to the high cost of fabrication of nanostructured photovoltaic device it becomes necessary and mandatory to model and to simulate them. As shown in the Figure. 1, the schematic structure of QD intermediate band solar cell contains bulk semiconductor material of p-type at the top, and n-type at the bottom, and a superlattice layer of QDs between them. Simulation of the nanostructured solar cell is a challenge as the device contains both bulk and quantum properties.

A formalism has been developed by hybridizing the Drift Diffusion equation and the Transfer Hamiltonian formalism to simulate the carrier generation and transport in a one-dimensional model for a Quantum Dot p – i – n junction solar cell. The simulation of the current voltage relationship of the bulk material is done using Drift Diffusion equation, whereas, the current voltage relation through the nanostructures is done using the Transfer Hamiltonian formalism.

The Detailed balance efficiency limit calculation for Quantum Dot intermediate band photovoltaic cell is used to check whether our Hybridized formalism gives results within the physical bounds



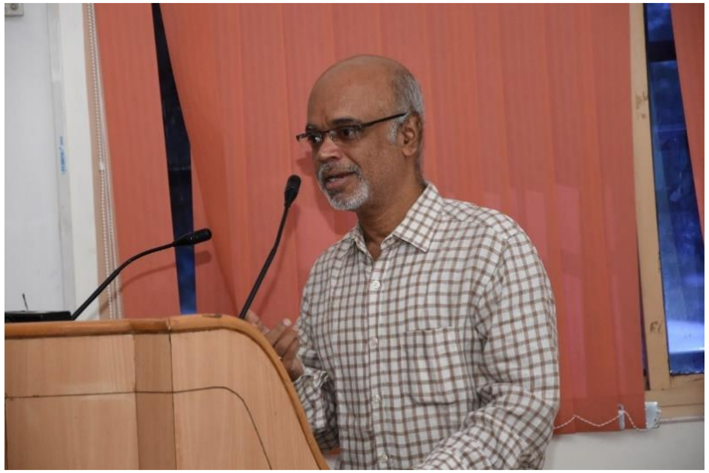
Schematic structure of quantum dot intermediate band solar cell

http://mbe.rcast.u-tokyo.ac.jp/index_eng.html

Solar Panels of different materials and structures.

https://www.indiamart.com/proddetail/solar-power-plants-9154482333.html

Prof. Ganesh Prasad
Professor



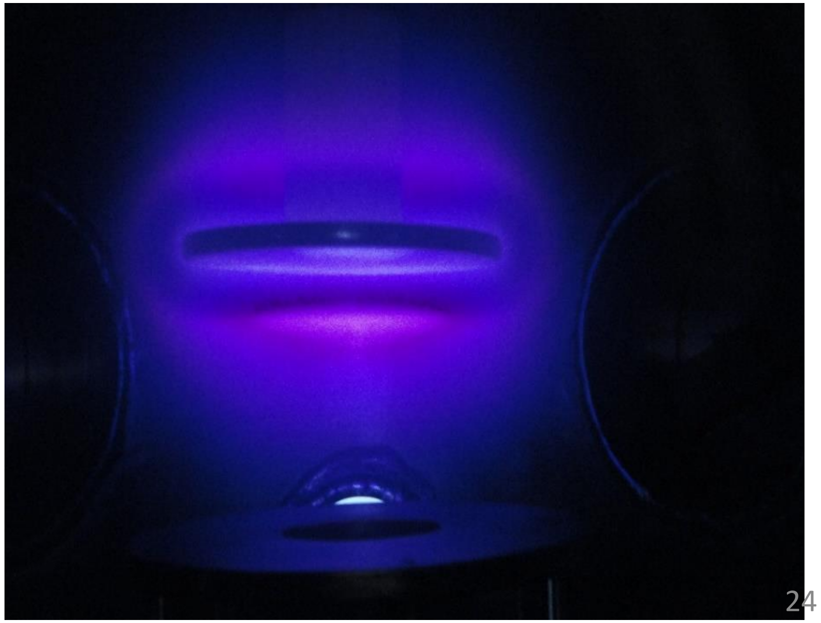
M.Sc.: Gulbarga University, Karnataka, 1984
Ph. D.: Gujarat University, Gujarat, 1993
Post Doctoral Fellow: Equipe Turbulence plasma, Marseille, France

Prof. Prasad has 10 years of research experience at IPR. He worked on experimental measurement of Rayleigh-Taylor and drift waves in his Ph.D time. He worked on thermal plasma torches and production of sub-micron sizedAlN. He has built in-flight plasma reactor for spherodisation of metals and metal oxide cermics. In-flight reactor was used Zircon sand dissociation.

He developed dusty plasma group at IPR conducted experiments with his students on dust acoustic waves, transverse waves, shock waves dusty vortex structures etc. He worked on atmospheric pressure glow discharge plasma generation and characterization and its application to air drag reduction. He has developed different types plasma torches for industrial applications. He is the recipient of Dr. Vikram Sarabhai state award in the year 2003 on Plasma pyrolysis process development for medical and hospital waste disposal. He became an entrepreneur and delivered plasma equipment to industries and Institutes. He joined IAR as Professor and Director of the Centre for Engineering and Enterprise in 2017.

Research Interests:

Development of different plasma sources for basic studies and industrial applications. Experimental measurement of plasma waves and instabilities, Dusty plasmas process, Industrial plasma process development and technology transfer. Presently working synthesis highly spherical metal and metal alloy powders using Plasma Rotating Electrode Process (PREP).



DC Glow discharge plasma sources.

Dr. Payal Pandit
Assistant Professor

B.Sc. (Physics): M.G. Science Institute, Gujarat University, 2006
M.Sc. (Physics): School of Sciences, Gujarat University,2008
Ph. D.: Kadi Sarva Vishwavidhyalaya, 2017

Dr. Payal Pandit joined as Assistant Professor of Physics at IAR, Gandhinagar in April 2018. During her Ph.D. she worked at Institute for Plasma Research, Gandhinagar under the BRFST fellowship scheme. She worked on direct measurement of plasma potential using laser heated emissive probes. After completing her Ph.D., she joined IPR as a Post-Doctoral Fellow to work on near infrared plasma spectroscopy of the limiter/divertor region of the Aditya-U tokamak to study the edge plasma parameters and divertor detachment feedback control. She is actively involved in teaching post-graduate and under-graduate programs in physics . She is also actively involved in regular up gradation of physics laboratory and looks after the regular lab operations.

Email: payal.pandit@iar.ac.in
More at: http://iar.ac.in/faculty2-engi-payal-pandit.html

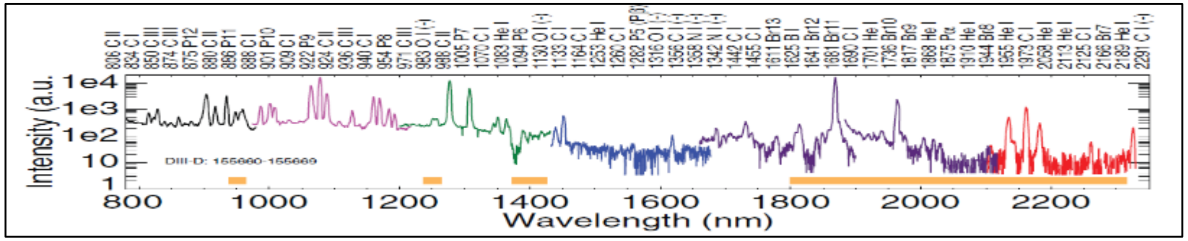
Research Interests: Plasma Diagnostics

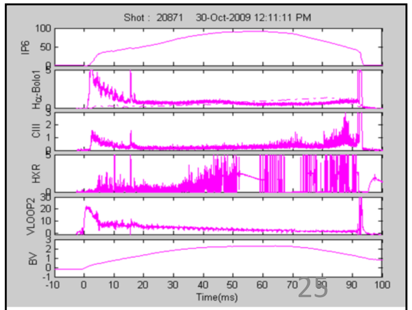
Tangential view port on Aditya-U tokamak for NIR plasma Spectroscopy

Energy crisis is growing by the day and the continuous use of non renewable sources is posing a serious problem. Alternate clean source of energy is the need of the hour. Controlled thermonuclear fusion can provide answers to this problem. This takes place in the plasma state which is the fourth state of matter by fusion of two hydrogen nuclei resulting in a helium nucleus and tremendous amount of energy. It thus becomes important to study the plasma state.

Attempts are being made worldwide to produce and confine plasmas and study them. One such configuration is called a tokamak in which the plasma is confined toroidally using magnetic fields. Plasma diagnostics thus play an important role in monitoring the confinement mechanism and impurity concentration. Plasma spectroscopy is one such tool to monitor and identify the impurity radiation from the tokamak plasma and estimating the plasma parameters. My present research interest, which is a Near-Infrared Spectroscopy diagnostics system, for edge and divertor plasma spectroscopy of Aditya-U tokamak is useful for plasma parameter measurement and neutral particle influx measurement. This can provide real time feedback to the confinement mechanism and identify the population mechanism as well as the extent of divertor detachment.

NIR Survey spectrum on DIII-D tokamakRef: V.A. Soukhanovskii et al Rev Sci Instrum 85 11E418 (2014)





A Typical Aditya Plasma Discharge

Dr. Sudhir Bhatt
Assistant Professor

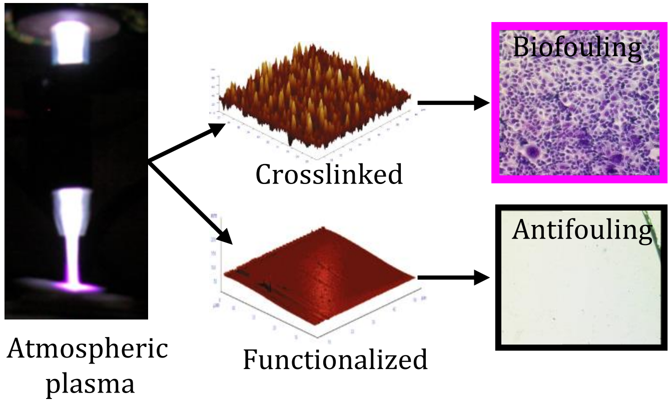
B.Sc.(Physics): Sardar Patel University, India, 2004
M.Sc. (Physics): Dept. of Physics, Sardar Patel University, India, 2006
Ph.D (Experimental Plasma Physics): Université Pierre et Marie Curie (UPMC) Paris, France, 2013
Postdoctoral Research: UPMC, France 2013-2014, Old Dominion University, USA, 2014-2017
Assistant Professor (Research): Old Dominion University,USA,2017-2018

Email: sudhir.bhatt@iar.ac.in

Dr. Sudhir Bhatt received his PhD in 2013 in Plasma Physics and Plasma Processing of nanostructured materials for biomedical applications from UPMC France. Till 2018, he was working as a Research Assistant Professor at the Old Dominion University USA in collaboration with Department of Health, UK. His research interests primary focus on two non-thermal plasmas for surface engineering and design, development and optimization of non-equilibrium plasma sources for decontamination of complex medical devices such as endoscopes. While working with FCIPT, IPR, Gandhinagar in 2006, he has earned expertise for industrial plasma applications for plasma diagnostics, thin film characterizations and development of solar-electricity conversion materials such as PV cells. He has authored 15 peer reviewed research papers (14 research articles + 1 review paper) which are in high impact international journals with citations of 241 and h index of 10. His research work has-been presented (Oral and Poster) at 20 International and 2 national conferences. He has an active international collaborations with various world class laboratories, industrial and academic institutions including but not limited to Tokyo tech, (Japan), European Commission Joint Research Centre (Italy), Technical University of Catalonia (Spain), CNRS (France), Department of Health (UK), ODU (USA) and many others. Since Feb, 2019, he is working at IAR as an Assistant Professor of Physics.

Research interest : Atmospheric pressure plasmas for functionalized "Smart surfaces" for biomedical applications

With respect to low-pressure plasmas, atmospheric pressure plasmas avoid the use of expensive pumping systems and vacuum chambers, and can be integrated much easier in the fabrication lines for industrial use, offering a comprehensive range of reactor configurations, working gases and reliable surface processing options, as reported in a large number of articles and reviews [1-4]. In the noble gas plasmas of inert gases such as Ar, He, Ne and so on, in the absence of residual air, the radicals formed on the polymer surface by the CASING (cross-linking by activated species of inert gas) process are not quenched by other reactive species and therefore can react with each other to give cross-linked surfaces. In the plasma-induced grafting or plasma grafting, new functional polymer chains are added to the polymer surface from polymerisable precursors such as acrylic acid, allylamine and so on whereas, in the plasma activation/functionalisation process, only chemical functionalities are generated on the surface by way of reactive and non-polymerising gases such as O_2, N_2, and so on. Plasma crosslinked surfaces are more prone for cell adhesion and a functionalized coatings are allow the cells to adhere on it. Dr. Bhatt has expertise develop different plasma sources for the deposition of various organic precursors for controlled adhesion or antifouling properties of biomedical surfaces for tissue engineering applications. He is interested also in plasma diagnosis and thin film characterizations.



References:
1. S.Bhatt et al. Surface Innovations, 2015.
2. S.Bhatt et al. Oncotarget 2016
3. S. Bhatt et.al Plasma Processes Polym, 2014
4. S. Bhatt et al. ACS Macro Lett. 2012

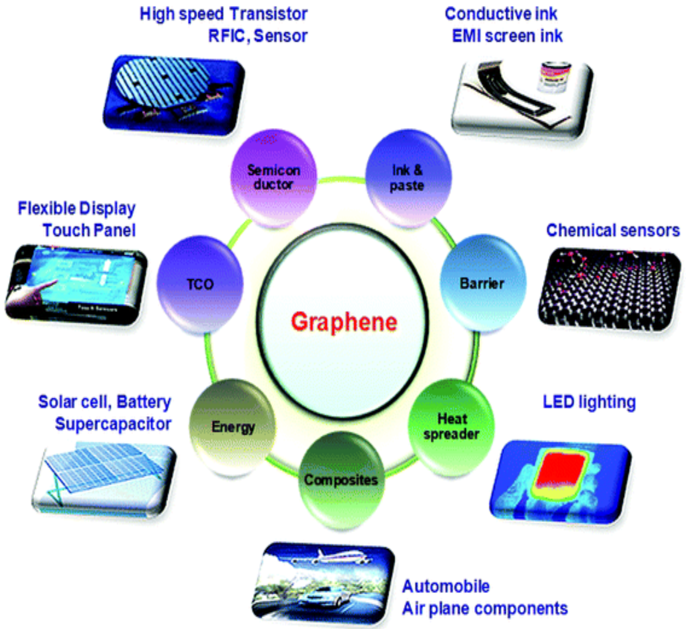
Dr. Hasmukh Gajera
Assistant Professor

B.Sc. (Physics): Navyug Science College, VNSGU, Surat, 2008
M.Sc. (Nano Science & Nano Technology): Dept. of Materials Sciences, Sardar Patel University,2010
Ph. D. (Materials Science): Dept. of Materials Sciences, Sardar Patel University,2016

Dr. Hasmukh Gajera has recently joined as Assistant Professor of Materials Science at IAR, Gandhinagar. During his Ph.D. he worked at Department of Materials Science, Sardar Patel University, Vallabh Vidyanagar under University Grant Commission (UGC)'s Meritorious Scheme. He worked on Studies on synthesis of graphene by chemical method and conducting polymer matrix composites therefrom.

Email: hasmukh.gajera@iar.ac.in
More at:

Research Interests: Graphene and its applications



Graphene research has accelerated exponentially since 2004 when graphene was isolated and characterized for the first time utilizing the 'Scotch Tape' method . Graphene is one of the hot topic of research not only in materials science but also in other science and engineering fields. This is due to its extraordinary properties like conductivity, optical transparency, mechanical and other properties. Main research interest with graphene in the area of conducting polymer based nanocomposites for advanced applications. Graphene for waste water treatment to support the clean water problem of current time .

https://sites.google.com/site/grapheneeeeeeeeeeeee/

Ms. Divya Dileep

B.Sc. Physics, C.M.S College, M.G University Kottayam, Kerala, 2009.
M.Sc. Physics, Women's Christian College, University of Madras, Chennai, 2011.
M.Tech. Optoelectronics and Laser Technology (University Rank holder),B.S AbdurRahman University, Chennai.

Mrs. Divya Dileep is a Lecturer at IAR (Department of Physical Science). She has worked as JRF in Institute for Plasma Research Gandhinagar where she was working on DST funded project on CZTS solar cells. After completion of the project she has acquired one year of teaching experience. She is involved in teaching B.Tech and Masters Students.

Research Interests

Dye Lasers:

Dye lasers offer efficient emission in the visible and infra-red bands by direct generation of laser light. They offer a range of valuable characteristics and significant flexibility which makes them applicable for wide variety of applications. I have designed and characterized energy transfer distributed feedback dye laser (ETDFDL) including Zinc oxide nanoparticle dispersed active region, she had studied the characteristics of Nd-YAG laser pumped Energy Transfer Distributed Feedback Dye Laser, using organic dyes coumarin- 503 (C-503) and coumarin-540 (C-540) as the donor and acceptor dye respectively.

CZTS Solar cells:

Solar cells harness energy from the sun and transform it into usable energy. Generally solar cells contain expensive and rare elements, this result in the higher cost of solar cells, CZTS solar cells helps us to overcome this concern as it contains elements that are abundantly available and are Torr) condition and has optimized its efficiency by varying component concentration as well as
Sputtering conditions.

Prof. A. Prasanna
Visiting Professor

Prof. Dr A.R. Prasanna, Honorary Professor, at the Physical Research Laboratory, was formerly Dean, & Senior Professor at P R L. Ahmedabad., and was the Director of L J Institute of Computer Applications, Ahmedabad, during 2008-13. He obtained his Ph.D degree in Applied Mathematics (General theory of Relativity) from the University of Pune in1970 and then served as a visiting Scientist at the International Centre for theoretical Physics, Trieste, Italy. He was awarded, the prestigious Alexander von Humboldt fellowship in 1973, to work at the University of Bonn in Germany. His main field of research is Gravitation physics and theoretical astrophysics. He has over ninety five research publications in reputed (peer reviewed) international journals. He has served on various national bodies on General relativity and was the convener for the National coordinating committee for General Relativity and Gravitation of the UGC during 1981-86. He was a member of the working group of United Nations workshop on Space Science and Technology and its applications within the framework of educational system. His book on "**Space and Time to Spacetime**", was published by the Universities Press in 2008. More recently (2016) he has published a treatise on **"Gravitation**", commissioned by the CRC Press U.S.A., for the Taylor and Francis group, UK. He has written and spoken extensively to the students at various levels on topics of science with an aim to demystify Physics and has produced (1980) a six part TV serial on Cosmology for distance education of UGC, apart from giving several radio presentations.

Few important publications

Prasanna, A.R. "General relativistic analysis of charged particle motion in electromagnetic fields surrounding black holes" (Review article, Revista del Nuovo Cimento 3 (11) p. 1-53, (1980).

Ehlers, J., **Prasanna, A.R.** and Breuer, R. " Propagation of gravitational waves thorugh pressureles matter" Classical and Quantum Gravity 4, p.253-264, (1987).

Abramowicz, M.A. and **Prasanna, A.R.** "Centrifugal force reversal near a Schw¨arzschild blackhole", Mon. Not. R. Astr. Soc. 245, p.720-728, (1990).

Ehlers, J. and **Prasanna, A.R.** "A WKB Formalism for Multicomponent Fields and Its Application to Gravitational and Sound Waves in Perfect Fluids", Classical and Quan. Gravity, 13, p. 2231-2240,(1996).

Prasanna A.R., "Propagation of Gravitational Waves through a Dispersive Medium", Phys. Letts. A257, 120-122 (1999).

Mohanty S. and **Prasanna A.R.**, "General Relativistic Contribution to Polarization of the Cosmic Microwave Background", Phys. Rev. **D63**, 027301-4, (2000)

Prasanna A.R. and Mohanty S., "GravitationalWave Induced Rotation of the Plane of Polarisation of Pulsar Signals", Europhysics Letters **60**,(5),p 651-655,(2002)

G.Lambiase and **Prasanna A.R.**,"Gauge invariant wave equation in curved space-times and primordial magnetic fields", Phys.Rev D,**70**,063502, (2004)

Subhendra Mohanty ,**Prasanna A.R.**,and G.Lambiase, "Leptogenesis from Spin-Gravity Coupling following Inflation",Phys. Rev. Lett. **96**, 071302 (2006),

G.Lambiase,Subhendra Mohanty and **Prasanna.A.R** "Neutrino cou-pling to cosmological background:A review on gravitational Baryo/Leptogenesis, International Journal of Modern Physics D22,(12),1330030, (2013),

Prasanna.A.R "On Photon trajectories and electromagnetics near strongly gravitating Cosmic sources" Invited Review to appear in Journal of Electromagnetic Waves and Applications, (2015)

Awards :

- Five times awarded "Honorable Mention" by Gravity Research Foundation, USA for Essays on Gravitation (1974, 1978, 1982, 1989 and 1993)
- Vaidya –Raychaudhuri award from IAGRG, 2016

Ph. D. Student

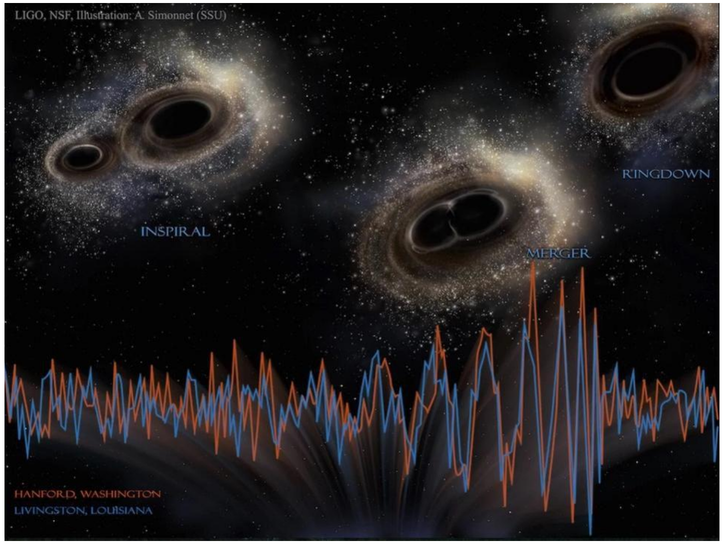
Mr. Chetan Verma

B.Sc. : M.J.P Rohailkhand University, Bareilly, 2011
M.Sc.: Aligarh Muslim University, Aligarh, 2013

Qualified: CSIR-UGC Junior Research Fellowship
Ph. D. Supervisor: Dr. Gurudatt Gaur

Email: Chetan.verma@iar.ac.in

Research Project: Gravitational Wave Physics



Astronomical compact binary systems such as black hole - black hole or black hole - neutron star or neutron star - neutron star are very well studied sources of gravitational waves to be detected by the ground based gravitational wave detectors. I am currently working on detection of gravitational waves in the data from the network of detectors. I will also work on the techniques used for estimating the parameters of the gravitational waves.

Image : Three different stages of two colliding black holes of different masses.

Image source :
https://www.forbes.com/sites/startswithabang/2017/06/28/how-uncertain-are-ligos-first-gravitational-wave-detections/#546d743b1852

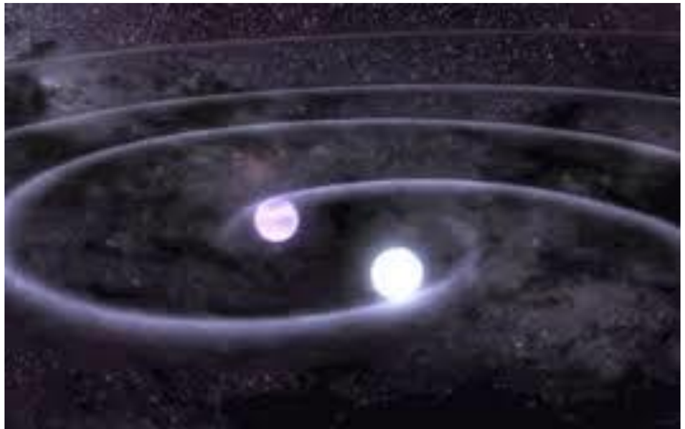


Image : Two colliding neutron stars

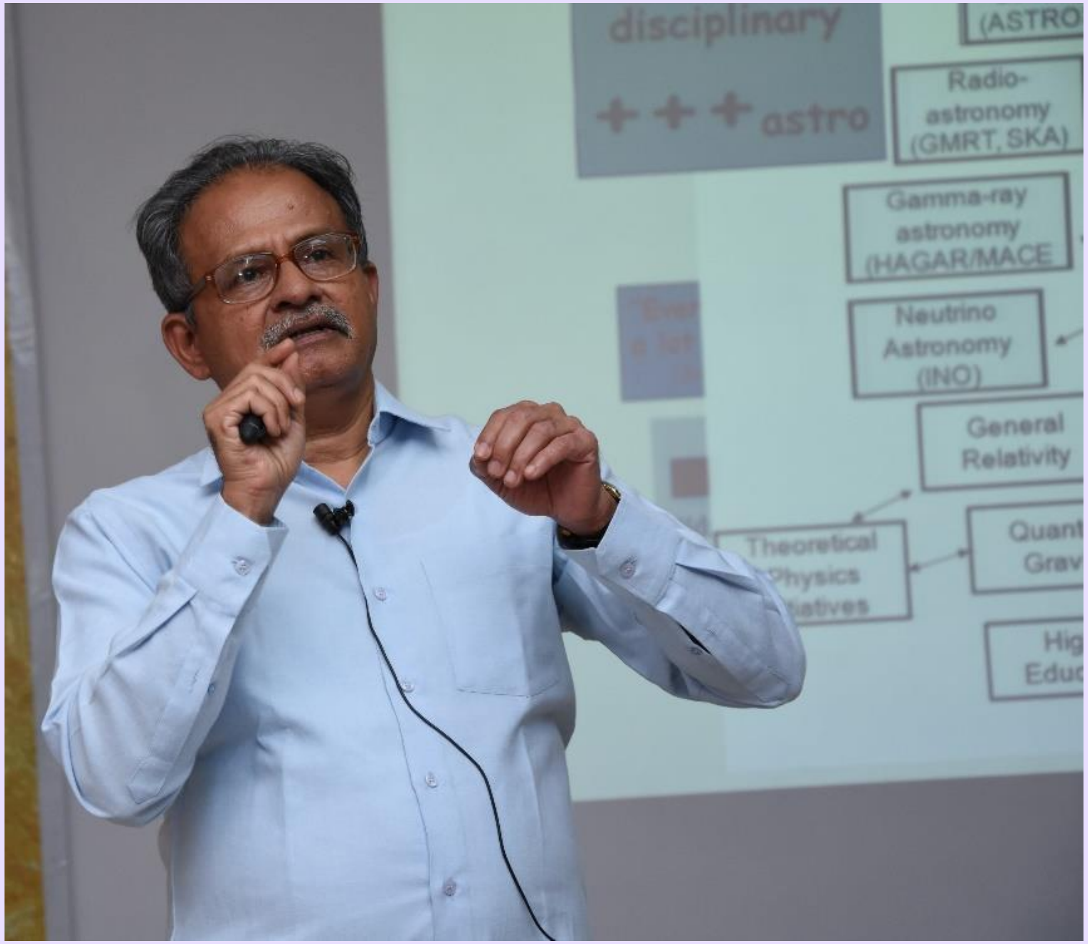
Image source :
https://www.youtube.com/watch?v=g8s81MzzJ5c

Activities of the Physics Discipline

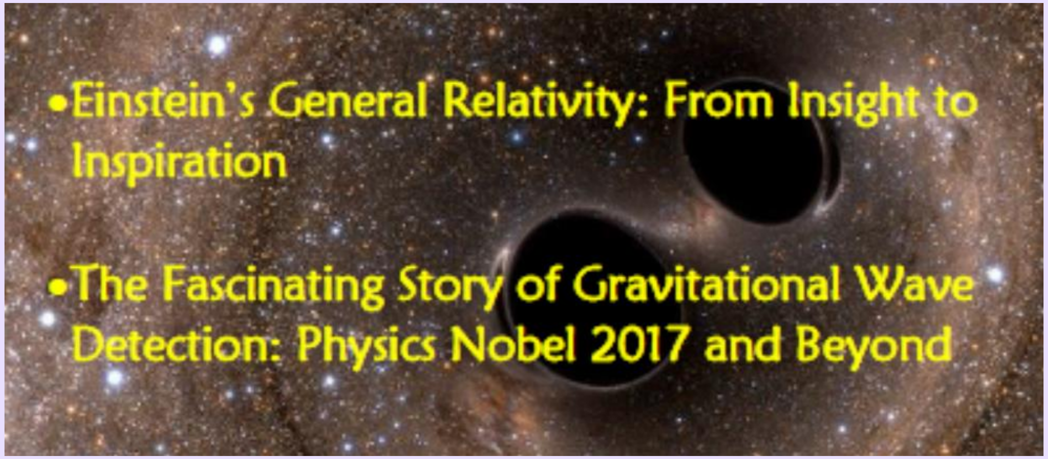
- Public Lectures
- Conferences
- Scientific Tours and Visits
- Invited Class-Room Lectures

Upcoming Activities:

- PSSI-Plasma Research Scholars' Colloquium
- Activities via ICARD (IUCAA Centre for Astronomy Research and Development)

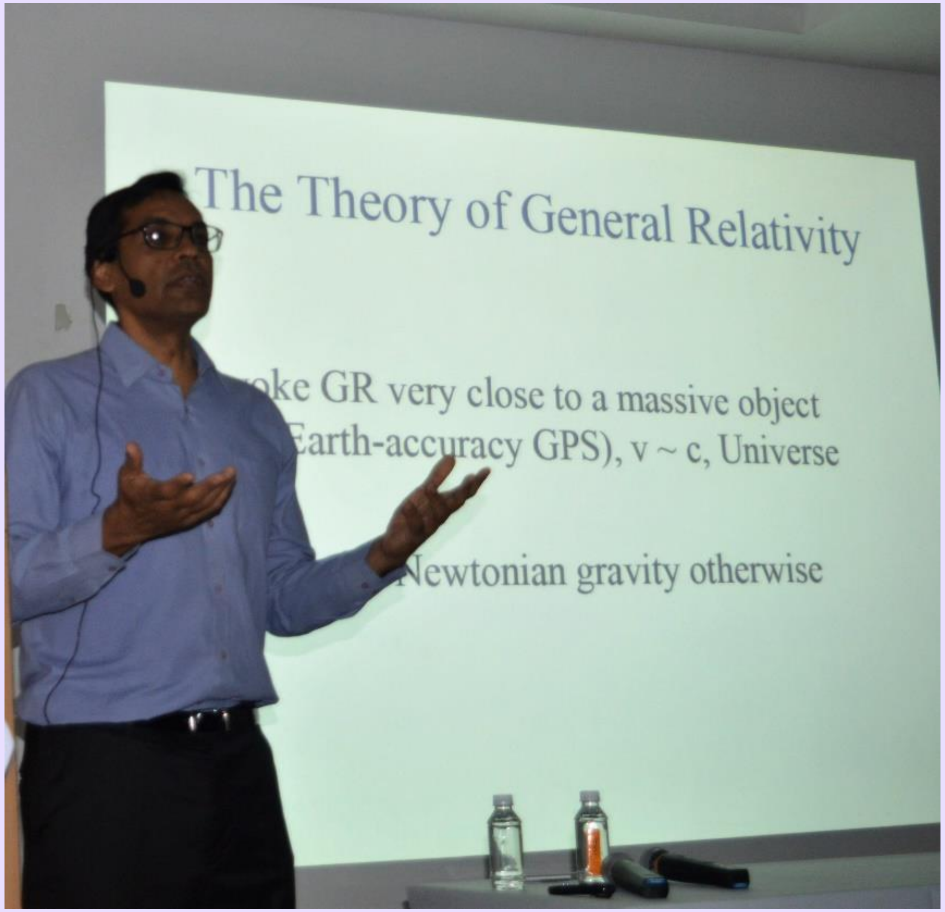


Prof. Bala Iyer from ICTS-TIFR Bangalore delivering public lectures at IAR.

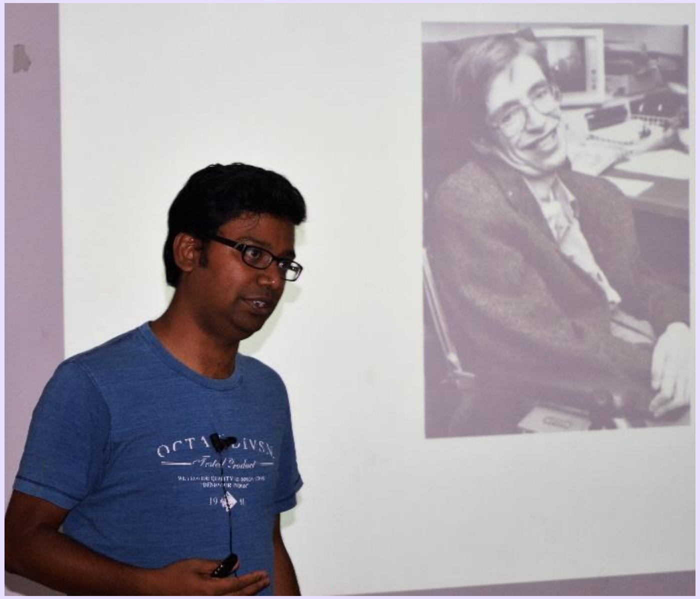


- Einstein's General Relativity: From Insight to Inspiration
- The Fascinating Story of Gravitational Wave Detection: Physics Nobel 2017 and Beyond

Physics Faculty and Students interacting with Prof. Iyer after his lecture.


The Theory of General Relativity
oke GR very close to a massive object
Earth-accuracy GPS), v ~ c, Universe
Newtonian gravity otherwise

Prof. Raghavan Rangarajan from Ahmedabad University, delivering a public lecture on the 'Story of our Universe' at IAR.



Dr. Sudipta Sarkar from IIT-Gandhinagar delivering a lecture on 'Hawking and His Universe' at IAR.

Prof. Rajaraman Ganesh from Institute for Plasma Research, delivering a public lecture on the 'Patterns in Nature' at IAR.

Prof. Sukanta Bose from IUCAA Pune delivering a public lecture on the 'Testing Einstein with Black Holes and Neutron Stars' at IAR.

MSc students' visit to Institute for Plasma Research, Gandhinagar.

Conference on Recent Progress in Physical Sciences, 2016.

Prospective Career Options

Science and technology has a strong influence in our day-to-day life and with such increasing dominance BSc with a specialization in Physics which is one of the most well established and recognized degree in science will lead to a variety of career options (mentioned below). A Masters degree in Physics will help in specializing in areas of chosen interest (in Physics) and pursue higher studies (doing a PhD) or choose some of the career options mentioned below.

❑ Career options after MSc

- PhD Scholar
- Project Student
- Research Scientist
- Teacher
- Lecturer
- Computer Programmer
- Data Analyst
- Laboratory Manager

❑ Career options after BSc

- Science Teacher
- Higher Studies towards Masters and PhD
- Research Assistant
- Technical Officer
- Computer Programmer
- Data Analyst
- Scientific Officer

The graduating batch (Physics) during Convocation.

From Left: Bhavesh, Jayesh (Computer Science),Raunak, Hardik, Archana, Bijal, Mr. Ashwani Puri, Nishka, Sneh, Dr. Gurudatt Gaur and Dr. Jaita Banerjee

For a detailed syllabus and any other queries (regarding Fee Structure/Hostel availability etc.,) please email us at:
gurudatt.gaur@iar.ac.in
jaita.banerjee@iar.ac.in
Or call us at: +91-79-30514**368/221**

How to reach IAR: